424mcd2018

Master Course Description for EE-424, EE-524 (ABET sheet)

Title: Advanced Systems and Synthetic Biology

Credits: 3

UW Course Catalog Description

Coordinator: Georg Seelig, Professor, Electrical and Computer Engineering

Goals: For students to acquire the necessary tools and knowledge for understanding the dynamic behavior of cellular systems together with engineering principles for the redesign of synthetic biochemical systems.

Learning Objectives: At the end of this course, students will be able to:

1. *Understand* the different modeling approaches used to represent cellular networks (Structural, Continuous and Stochastic Approaches).
2. *Understand* the differences between the fundamental cellular subsystems, metabolic, protein and genetic and how this influences potential engineering approaches.
3. *Develop* an appreciation for the need for standards and ontologies in model exchange and part representation.
4. *Understand, implement and use* a variety of computational approaching including FBA, MFA, Bifurcation and evolutionary methods.
5. *Understand* the basic principles of metabolic control including small signal analysis and elementary mode analysis.
6. *Learn* how to carry out a robustness analysis of a metabolic pathway and propose strategies for engineering pathways.
7. *Understand* the control of protein networks, highlighting differences and similarities with genetic and metabolic systems.
8. *Use* computational analysis to study the dynamic properties of protein networks and the design of robust systems.

Textbook: None

Prerequisites by Topic:

1. Introduction to Synthetic Biology, EE-423

Topics:

1. The importance of network structure in cellular networks
2. Review of continuous and stochastic models of cellular networks
3. The interplay between structure and dynamics
4. Design approaches in synthetic biology

5. Bifurcation analysis and evolution of networks
6. Standards and ontologies
7. Control systems in metabolism
8. Control systems in protein networks
9. Robustness and small signal analysis
10. Metabolic engineering strategy
11. Protein networks
12. Protein engineering
13. Advanced software for synthetic biological design and analysis

Course Structure: The class meets for three lectures a week (MWF). There is weekly homework due; Grading is based on homework, one midterm exam, and a final exam. The grading percentages and nature of the exams are left to the discretion of the instructor. The course will use MATLAB or any other suitable software platform for homework problems. The students complete an average of 3 hours of computer work per week.

ABET Student Outcome Coverage: This course addresses the following outcomes:

H = high relevance, M = medium relevance, L = low relevance to course.

(1) *An ability to identify, formulate, and solve complex engineering problems by applying the principles of engineering, science, and mathematics* **(H)** Lectures and homework deal with the application of software, modeling, differential equations, and linear algebra to synthetic biology.

(2) *An ability to communicate effectively with a range of audiences* **(M)** Students will prepare and present literature reviews and projects.

(3) *An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts* **(M)** Ethics and risks of synthetic biology and biotechnology will be covered.

(4) *An ability to acquire and apply new knowledge as needed, using appropriate learning strategies* **(H)** Students will solve open ended problems requiring literature review and creative problem solving.

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